A STUDY OF PHOTOLUMINESCENCE IN GLASSES

BY

ANTONIO RUIZ RODRIGUEZ

B.S., University of the Philippines, 1931
M.S., University of the Philippines, 1938
M.S., University of Illinois, 1940

AN ABSTRACT OF A THESIS

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
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ENGINEERING IN THE GRADUATE SCHOOL OF
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A STUDY OF PHOTOLUMINESCENCE IN GLASSES

Introduction

Some general considerations are given regarding the practical and theoretical interest of fluorescent glasses. A brief exposition of its nature and the origin of its spectra is presented.

Literature

The literature on this study of photoluminescence in glasses is summarized.

Experimental

The fluorescence spectra were taken with a constant deviation Hilger spectrometer provided with photographic attachment. The details of the experimental procedure are described.

Results and Conclusions

The influence of composition, temperature, and heat treatment on the photoluminescence of two distinct types of luminescent glasses were studied. From the behavior of their spectra it was possible to distinguish clearly between the two types and obtain information as to the nature of the fluorescing center.

One type of photoluminescent glass studied was the uranium glasses in which the fluorescing center is due to a coordination group of uranium and oxygen, known as the uranyl group, UO_2.

A correlation appears to exist between the emission of uranium glasses and the radii and quantity of the secondary cations present in the base glass. The intensity of fluorescence in general diminishes with decreasing ionic radius and decreasing amount of secondary ions in the glass structure. This is explained on the basis of the disturbance created by the undirected electrostatic field of the secondary cations. Slight shifts in the spectrum were also observed in substituting the secondary cations in the silicate glasses but the general character of the spectrum remained unchanged.

The characteristics of the spectrum, however, changes completely when one goes from a silicate to a phosphate or to a borate glass of equivalent composition. The spectrum becomes richer in structure as we go from a borate to a silicate and finally to a phosphate glass. This is explained on the basis that more oxygen is brought in the glass as we go from a borate to a silicate and finally to a phosphate glass without increasing the interfering secondary cations. The protecting sheath of oxygen around the uranium ion increases, thus enabling it to emit with less disturbance. The primary cation probably has no direct influence on the emission as its bonds, unlike the secondary cation, are directed bonds. It appears also that the manner in which the oxygen is linked in the glass structure (tetrahedra or triangles) does not influence the fluorescence to any appreciable extent. It merely depends on the number of oxygen atoms the primary cation can furnish.

Raising the temperature diminishes the fluorescence of uranium glasses continuously with a shift towards longer wave lengths in accordance with the earlier findings. New bands begin to make their appearance at temperatures of —100°C.

Heat treatment does not seem to alter the fluorescence of uranium glasses appreciably.

The second type of fluorescent glasses studied was the copper ruby glasses which, as evidence shows, have as fluorescing centers, copper atoms or, probably, very small groups of copper atoms. The intensity of fluorescence tends to increase towards higher silica and lime contents. It has, also, a marked phosphorescence which increases with the silica content and diminishes with increasing lime content. The highly phosphorescent glasses are poorly fluorescent and vice-versa.

The fluorescent temperature relationship in this type of luminescent glass shows a maximum around 86°C. The results indicate that the fluorescing centers are probably not only individual atoms but also very small groups of atoms. Evidences also point out the fact that the electrons may be detached from the excited center and may wander in the glass network.

VITA

Antonio Ruiz Rodriguez was born in Manila, Philippines on December 6, 1907. After his graduation from High School he entered the University of the Philippines in 1927. He received his B.S. in Chemistry from the same University in March 1931. In his senior year, he served as student assistant in chemistry. After his graduation, he was appointed as assistant instructor in chemistry. He received his Master's degree from the same University in 1937. In the same year he was promoted to the instructorship. Later in the year, he received a scholarship to study ceramics abroad.

He spent one year in the Technische Hochschule in Charlottenburg, Berlin, studying the subject. In the fall of 1938 he came to the United States and took up graduate work in ceramics in the University of Illinois from which he received his Master's degree in Ceramic Engineering in 1940.

PUBLICATIONS

The Electrical Conductivity of Antimony Trichloride in Chloroform. Natural and Applied Sciences (University of the Philippines) Vol. VII, No. 2, Oct. 1939 (with A. Clemente).